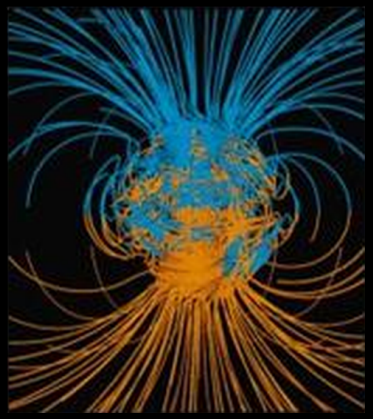


Phy2005
Applied Physics II
Spring 2018

Announcements:

January	19	F	**5**	Q3, 3, 4	19.1 - 19.5	charge, conductor/insulator, induced charge	pithballs, pingpong, electroscope
January	22	M	**6**	5, 9, 11, 12, 14,17, 19	19.6 - 19.7	Coulomb's law, superposition	
January	24	W	**7**	23, 27, 28, 31, 32, 37	19.8 - 19.12	E-field and electric potential	Faraday shielding, cell ph demo
January	26	F	**8**	40, 42, 48, 49	19.13 - 19.16	potential energy, motion of charge in E-field	van de graaff

Solutions to chapter 19 problems will be posted next Monday on HW page.

Last time: Electric charge

- Charge comes in units of +/- e

  +e = proton charge = 1.6 $x10^{-19}$C
  -e = electron charge = -1.6 $x10^{-19}$C

- Charge conservation – neither created nor destroyed

- Conductors and insulators

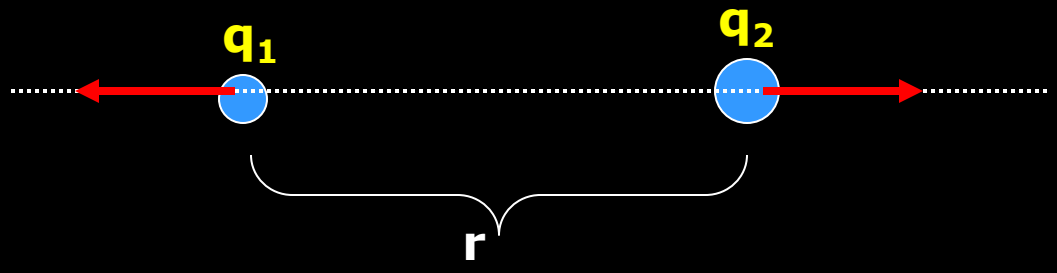
  - excess charge goes on surface of conductor
  - charging by induction

Today: Coulomb's law – electric forces

Coulomb's Law

$$F_E = k\frac{q_1 \cdot q_2}{r^2}$$

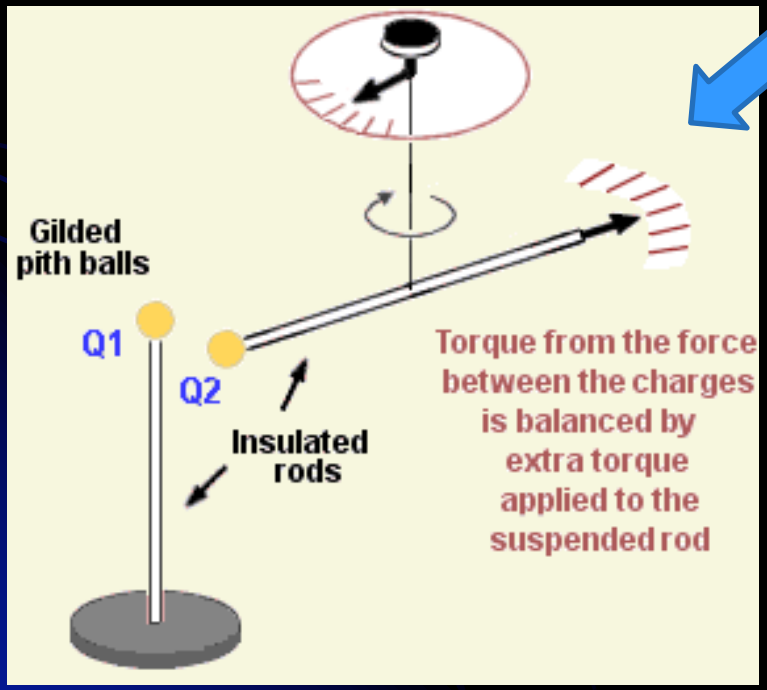
$k = 8.988 \times 10^9\ Nm^2/C^2$
$\approx 9.0 \times 10^9\ Nm^2/C^2$ Coulomb's constant

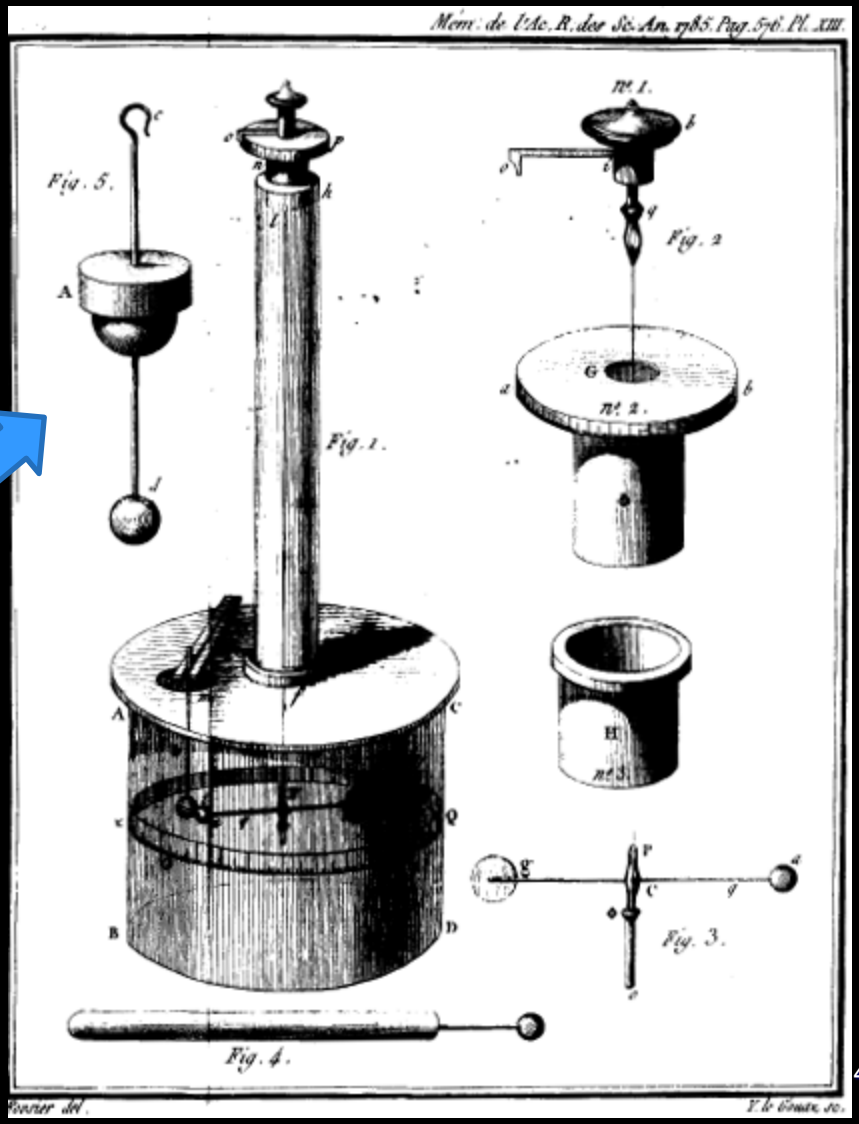


If q_1 and q_2 are both (+) or (-), repel each other.

$F_E > 0 \rightarrow$ repulsive
$F_E < 0 \rightarrow$ attractive

Charles Augustin de Coulomb (1736-1806)





Top Hat Quiz Time

ACADEMIC HONESTY

Each student is expected to hold himself/herself to a high standard of academic honesty. Under the UF academic honesty policy. Violations of this policy will be dealt with severely. There will be no warnings or exceptions.

Have your phone ready!

Ex 6-1 Two small conducting spheres are 0.5 m apart each other and carry net charges of +20 μC and -30 μC. What is the force acting on one sphere due to the other?

F = -21.6 N for both spheres

The (-) sign indicates that it is attractive.
It does not indicate the absolute direction of the force!!

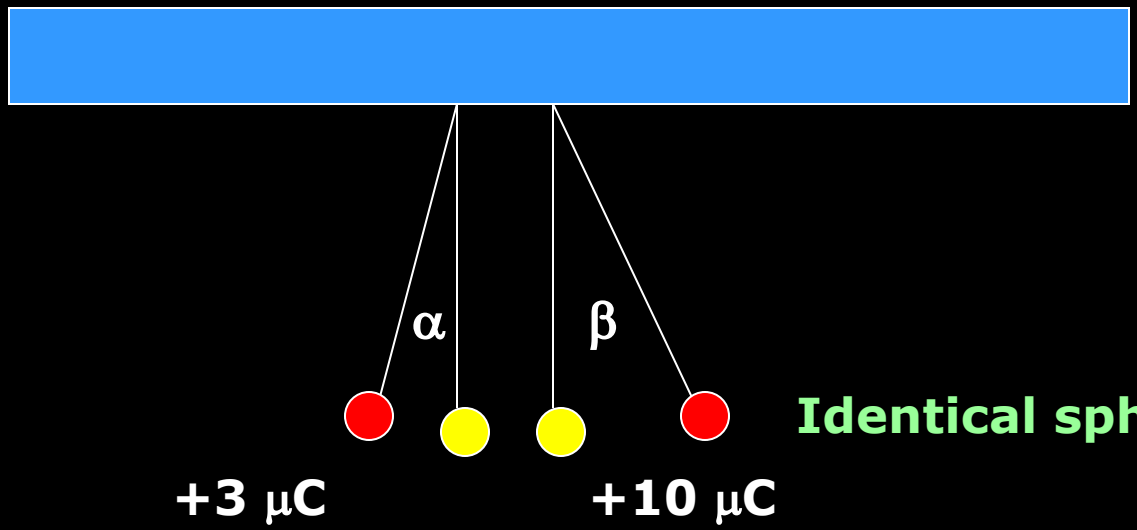
The forces acting on two spheres are in the opposite direction with the same magnitude.

attractive
(-) sign

Ex 6-2 Two identical conducting spheres are 0.5 m apart each other and carry net charges of +20 μC and -30 μC. They were brought together to touch each other and then separated back to their original positions. What is the Coulomb force acting on each sphere?

After the contact, each sphere carries -5 μC.
Same total charge before (+20 – 30 = -10 μC) and after (2 x (-5) = -10 μC): conservation of charge

F = +0.9 N (+) means repulsive!!



Which angle is bigger, α or β?
Why?

A: same

Coulomb force

$$F_E = k\frac{q \cdot Q}{r^2}$$

$k = 9 \times 10^9\ Nm^2/C^2$

can be repulsive and attractive!

Gravitational force

$$F_G = -G\frac{m_1 \cdot m_2}{r^2}$$

$G = 6.67 \times 10^{-11}\ Nm^2/kg^2$

can only be attractive!

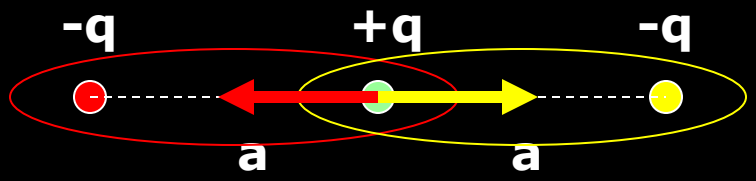
Ex 6-3 In the hydrogen atom, a single electron exists at a distance about 0.053 nm from a proton. Find the magnitude and direction of the Coulomb force exerted on the electron by the proton. How about the gravitational force?

Particle	Charge (C)	Mass (kg)
electron	$-e = -1.6 \times 10^{-19}$	9.11×10^{-31}
proton	$+e = 1.6 \times 10^{-19}$	1.67×10^{-27}

$F_E = -8.2 \times 10^{-8}$ N (attractive)
$F_G = -3.63 \times 10^{-47}$ N (attractive)

You can completely ignore gravitational effect in atoms!!

More than two charges? SUPERPOSE!!!



What is the net force on ● ?

$F_{●} = k(+q)(-q)/a^2 = -kq^2/a^2$

$F_{●} = k($

WRONG!

$F_{net} =$

$= -kq^2/a^2 + (-kq^2/a^2)$

$= -2kq^2/a^2$

Thought question:
Is this equilibrium stable?

No!!

Problem-solving Strategy
Coulomb's force

1. Make a clear drawing representing the problem:
   position of charges, distance, amount and type of charges.

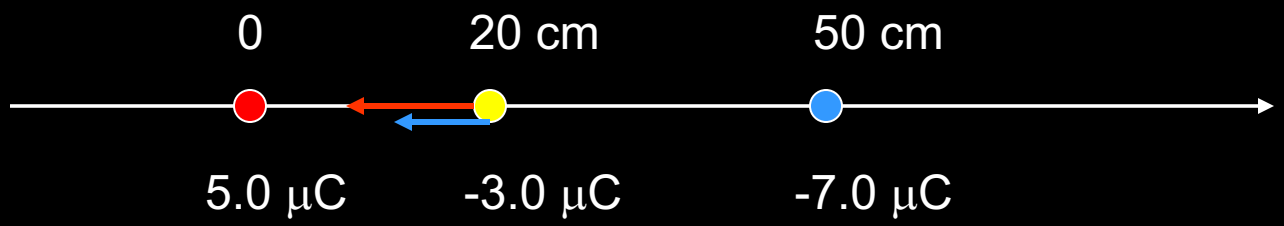
2. Identify all the pairs involving the charge of interest.

3. For a given pair, determine the type of force (attractive or repulsive) from the sign of the Coulomb's force and draw the force vector accordingly.

4. Repeat #3 for all possible pairs.

5. Do the vector sum to get the net force on the charge of interest.

Ex 6-4 Two point charges of +5.0 μC and -7.0 μC are located on the x-axis at x = 0 and x = +50 cm as shown in the figure. A third point charge with -3.0 μC is placed at x = +20 cm. What is the magnitude and direction of the force on the third charge?

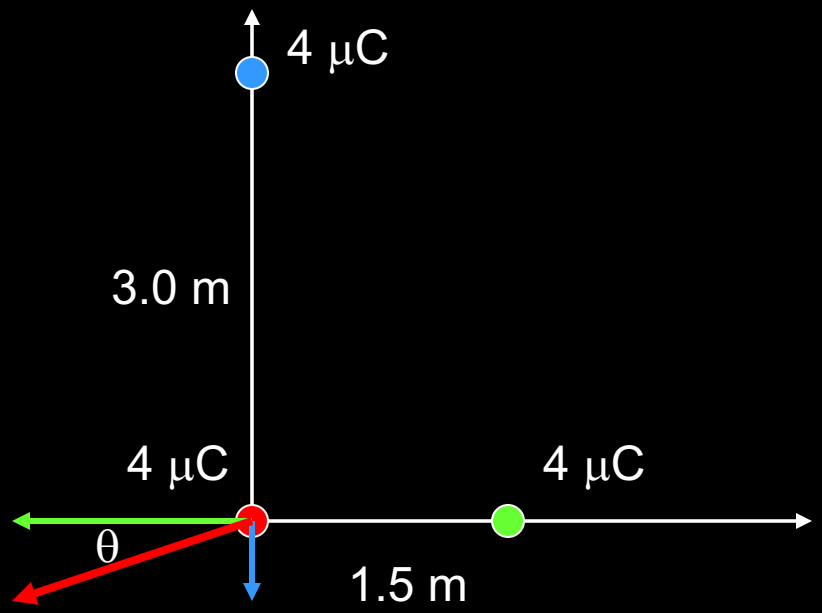


$F_{red} = 3.4$ N to the left
$F_{blue} = 2.1$ N to the left
$F_{tot} = F_{red} + F_{blue} = 5.5$ N to the left

Ex 6-5 Three equal 4.0 μC point charges are located at (0, 0), (1.5, 0), and (0, 3.0) in the x-y plane. The coordinates are in meters. Find the force on the charge at the origin.

$F_G = 0.064$ N (repulsive)
$F_B = 0.016$ N (repulsive)

$F_{tot} = 0.066$ N
$\theta = \tan^{-1}(F_B/F_G) = 14°$



Clicker Quiz Time

ACADEMIC HONESTY

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Log in your remote!

Q1 Which of the following statements is wrong?

(1) All the excess charge on the metal is on the surface of the metal.
(2) The directions of the pair of forces due to two charges are determined by the signs of the charges.
(3) Conductors have many charges that are free to move about.
(4) Coulomb force between two charges is inversely proportional to the distance between the charges.
(5) Coulomb force is much stronger than the gravitational force.

Q2 Two identical point charges with +2 μC are placed on x = 0 and 2 m, respectively. A third charge with -30 μC is put at x = 1 m. What is the force acting on the third charge in N?

(1) 0
(2) 0.54
(3) 0.036
(4) 1.08
(5) 2.16